PERFORMANCES OF *HETEROBRANCHUS LONGIFILIS* FINGERLINGS FED MAGGOT MEAL-BASED DIETS IN MINIFLOW THROUGH SYSTEM.

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Abstract.
The growth response, nutrient utilization, cost benefits and haematological responses of two hundred and fifty (250) *Heterobranchus longifilis* fingerlings fed maggot meal based diets were evaluated for 70 days in mini flow through system. Twenty fingerlings were stocked in triplicate in fifteen mini flow through system of plastic tanks of fifty (50) litres capacity and coded $MM_1 MM_5$ in relation to their diet name. Five isonitrogenous (40.0%) and caloric content (2017.9 2092.3kJ/100g) maggot meal based diets namely MM_1 0%maggot meal, MM_2 25% maggot meal, MM_3-50% maggot meal, MM_4- 75% maggot meal and MM_5- 100% maggot meal were used for the experiment. The higher the proportion of maggot in the meal, the higher the ether extract and crude fibre. No significant difference ($p>0.05$) existed between ash content of the experimental diets. Diet MM_2 had the best growth performance and highest MGR with a significant difference ($p<0.05$) with other diets fed fish. No significant differences ($p>0.05$) existed between the growth parameters for diets MM_1, MM_3, and MM_4. A positive correlation ($r = 1.0$) existed ($p<0.05$, 0.25) between the growth parameters for the different experimental diets. Highest correlation ($r^2 = 0.9981$) existed $p<0.05$ between MGR within the treatments. Highest Haematocrit (23%), Haemoglobin content (7.68g/dl) and whole blood clotting time (46 sec) were recorded from *H. longifilis* fed MM_5. Without any reservation, inclusion of maggot based meal diet is recommended as feed in the diet of *H. longifilis* to 75% replacement of fish meal for growth and better healthy condition so as to ensure sustainable aquaculture in Nigeria.

Key words: Maggot meal; fishmeal; growth; nutrient utilization; haematology.

Introduction

Heterobranchus longifilis is one of the major catfish species of the Family Clariidae. This fish inhabits freshwater bodies (Reed *et al.*, 1967 and Idodo-Umeh, 2003). Fagbenro (1989) reported that *Heterobranchus* is tolerant to low dissolved oxygen and other adverse aquatic conditions including high turbidity. *H. longifilis* feeds on any available food, including plankton, insects, fish, detritus, benthic invertebrates (annelids) and tadpoles (Olufeagba, 1999). The optimum protein requirement for the fingerling stage as reported by Fagbenro *et al.* (1992) is 42.5% crude protein. *H. longifilis* is a highly priced fish in Nigeria along with other African catfish species due to their good taste and flavour. The Nigerian fish farmers have not been able to meet the demand for the species by the populace. Hence, there is a need to boost the production of this highly commercially demanded culturable fish with high growth rate for food sustainability in Nigeria. Blood is a major index of physiological, pathological and nutritional status of an organism. Any change in the constituent component of blood sample when compared to the normal values could be used to interpret the metabolic state of the animal and the influence of treatment given to the animal (Babatunde *et al.*, 1992). Baron (1980) observed that haematological changes could be attributed to environmental conditions such as oxygen and food composition (like proteins, vitamins and mineral salts).

Hike in the price of fish meal and consequently compounded fish feed has led to the need for investigating into other alternative cheap sources of fish feed ingredients that will provide the required nutrient for the fish at cheaper cost if production from aquaculture sector and bridge the gap between fish demand and supply in Nigeria.

Maggot, the larval form of Housefly (*Musca domestica*) is not being competed for as animal protein source by man. This organism grows extensively on animal dung and food waste where it digests them to odour free "scum" with high nutrient value. Maggot is readily available and has been accredited for its high quality protein with amino acids profile showing its biological value to be superior to soybean and groundnut cake (Eyo, 2003 and Adejinmi, 2000). The study was embarked upon as part of contribution to resolve the problem of high price of protein source in fish feed.

Materials and Methods

Experimental system

The experimental was carried out indoor in the Fish Nutrition Laboratory of Aquaculture and Biotechnology Department of the National Institute for Freshwater Fisheries Research (NIFFR), New-Bussa, Nigeria.

Five experiment sets in triplicates were used for this experiment. A total of fifteen (15) indoor mini-flow through system, 0.25m depth and 0.55m diameter circular plastic tanks of 50 liters capacity each were used for the trials. Water was supplied to each tank from 30,000litres head tanks. Each unit had a control for comparison. The plastic tanks were cleaned, disinfected and allowed to dry for 24 hours, after which water was supplied to two-third of the size of the tank and were covered with a net of mesh size 3mm to protect the fish from jumping out of the tanks. A constant photoperiod of 12 hours light and 12 hours dark was maintained.

Experimental Fish

A total number of 250 fingerlings of *Heterobranchus longifilis* of weight range 1.69g -2.45g (mean = 1.98± 0.083g) and total length range of 6.2cm -7.2cm (mean = 6.5± 0.08cm) were purchased from the Hatchery Unit of NIFFR. They were acclimatized for one week in plastic holding tanks of 2.0m x 0.5m x 0.4m in the Fish Nutrition Laboratory of NIFFR, aerated with Erckman Electric Aerator and fed a compounded NIFFR-feed of 35% crude protein.

The fingerlings were randomly sorted, weighed, stocked into the indoor experimental tanks at the rate of fifteen fingerlings per tank and starved overnight before the commencement of the feeding trial. The fish were monitored for mortality daily. Dead fish were removed, counted and recorded for determination of survival rate.

Experimental diets

Five experimental diets were formulated and prepared for this experiment as shown in Table 1. Diet MM_1, which contains 0% maggots meal was used as the control. Diets MM_2, MM_3 MM_4 and MM_5- containing 25%, 50%, 75% and 100% supplemented maggot meal respectively. All diets were isonitrogenous at 40% and isocaloric at 4824.4-5002.5 kcal/kg.

Production of Maggot meal

Maggots used for this experiment were cultured according to (Nuov *et al*, 1995 and Madu and Ufodike, 2003) methods. The collection was done as described by Adejinmi, (2000) and Sogbesan *et al*., (2006) using screen nets. The maggots are photonegative, so in an attempt to escape from the traces of sunlight, they pass through the 3mm-mesh size net and were collected into a basin under the net. Maggots collected were weighed, dried under the sun and grounded into powdery form using blender machine.

Sampling and monitoring of the experimental fish

The length and weight of each fingerling in each tank was measured at the commencement of the experiment. Subsequently, 5 fingerlings were taken randomly from each tank once a week and weighed with beam balance to assess the growth rate. The sampling exercises were carried out in the morning before feeding the fish. Any dead fish is quickly removed and recorded to determine the survival rate. The experiment lasted for 10 weeks.

Water Quality

The water quality parameters were monitored by the staff of Limnology Division of NIFFR, New- Bussa, Nigeria, and average value for temperature, dissolved oxygen, hydrogen ion concentration (pH) and conductivity were 29.5°C, 5.8mg/l, 7.2 units and 220 μmhos cm^{-3} respectively.

Biochemical analysis

. Proximate composition was carried out using the Association of Official Analytical Chemists methods (AOAC 2000). The haematocrit was determined by the microhaemotocrit method, haemoglobin was determined using the cynomethaemoglobin method and the coulter haemoglobinometer (Coulter, U.K.). Whole blood clotting time was noted as the time (sec) that it took blood introduced into a syringe to start to clot.

Feed response calculations and statistical analysis

For this study, growth was expressed as weight gain, relative weight gain, specific growth rate, metabolic growth rate, condition factors (Bagenal, 1978) and survival rate (Fasakin *et al.*, 2001). Feed utilization indices were expressed as Feed conversion ratio, Protein efficiency ratio (Wilson, 1989) and protein rating (Steffens, 1981), as follows:

Mean weight gain = $W_f W_i / n$.

Relative Growth Rate = (Weight gain / Initial body weight) x 100.

Specific Growth Rate = (Log w Log w_1 / t) x 100.

Metabolic growth rate (MGR) = $\dfrac{\text{Live body weight gain} / \{(\frac{W_i + W_f}{2000})\}^{0.8}}{\text{Experimental period (days)}}$

Voluntary feed intake (VFI%) = $\dfrac{100 \times FI}{(W_i + W_f) \times t}$

Food Conversion Ratio= Feed intake (g) / Weight gain (g).

Protein efficiency rate = Weight gain /Protein intake

Protein rating = Daily protein intake x PER.

Cost benefits in terms of Profit Index (PI), incidence of cost (IC), and benefit cost ratio of substituting fish meal with maggot meal in the culture of *Heterobranchus longifilis* were determined according to New (1989), Faturoti and Lawal (1992) and Mazid *et al.* (1997).

Profit Index=Value of fish (N)/cost of feed (N)

Incidence of Cost=Cost of feed (N)/mean weight gain of fish produced (g)

Benefit: cost ratio (BCR) = $\dfrac{\text{Total cost of fish cropped (N)}}{\text{Total expenditure (N)}}$

All data collected were subjected to analysis of variance [ANOVA}. Comparisons among treatment means were carried out by one way analysis of variance followed by Tukey's test (0.05). Least Significance difference (LSD) was used to determine the level of significance among treatments. Correlation and regression analysis was carried out to determine the relationship between the treatments and some of the parameters using SPSS 10.0 Windows 2000 and Graph pad Instat packages.

Results

Average value for temperature; dissolved oxygen, hydrogen ion concentration (pH) and conductivity were 29.5°C, 5.8mg/l, 7.2 units and 220 µmhos cm^{-3} respectively.

The crude protein content of the five experimental diets were 41.16%, 41.43%, 41.71%, 41.98% and 42.25% for 0%, 25%, 50%, 75% and 100% maggot meal-based diet respectively (Table1). The highest crude lipid, 17.04% was in 100% maggot meal based diet while lowest crude lipid, 8.87% was in the control diet. The gross energy values, which are 1742.13kJ/100g, 1794.55kJ/100g, 1854.81kJ/100g, 1898.91kJ/100g and 1951.04kJ/100g increased as the maggot meal inclusion increased from the control diet to 100% maggot meal inclusion diet respectively. A gradual rise in the line graph of MM, from week 1 till week6 when there was a slight decrease and rise again in week 7 till the end of the experimental period. A gradual increase and rise in the slope of graph line MM_2 was recorded and shown in Figure 1. The growth pattern recorded in MM_5 did not rise sharply as seen in other diets. Highest mean weight gain of 8.73g/fish was recorded in MM_2 while the lowest of 4.80g/fish was recorded in MM_5. The highest SGR 1.01% was recorded in MM_2 while the lowest SGR, 0.72% was recorded in MM_5. All growth indices were insignificantly different (p=0.3614 and F = 1.198). The FCR ranged within1.63-2.01. Highest PER of 1.48 was recorded from MM_2 while the lowest 1.17 from MM_5 (see Table 3). The highest gross energy intake of 2560.82kJ/100g was recorded in MM_2 while the lowest of 1892.51kJ/100g was recorded in MM_5. Within the growth indices, highest significant correlation $r=0.9997$ ($p<0.05$) was recorded between specific growth rate and metabolic growth rate while the lowest $r=0.9914$ ($p<0.05$) was recorded between weight gain and specific growth rate. The feed utilization indices showed highest negative correlation $r=-0.9956$ between PER and FCR while the lowest of $r=0.0189$, $p>0.05$ existed between FCR and VFI. There was no significant difference between the feed utilization indices with $p=0.9699$, $F=0.1236$. The haematocrit and haemoglobin content were higher in maggot inclusion diet compared to the control. The best BCR of 1.55 was recorded from Mm_2.

Discussion

The use of maggot meal in *H. longifilis* diets appear to be advantageous especially as a reliable substitute for fish meal (clupeids) which is harvested from the wild is being frowned at by the Federal Government of Nigeria due to over exploitation by artisanal fishermen. The absence of negative effect on fish growth and physiology indicated that inclusion of maggot meal will not hamper both the development and well being of fish feed. Similar report had been made by Akpodiete and Okagbare (2000) when chicken were fed maggot meal. The study showed no significant difference in general haematological and serum of the chicken fed even in comparison to the control which indicated good quality of maggot meal as a good substitute for fish meal. Reduction in WBC showed a reduction in pathogenic load and need to shoot-up immunity to combat such pathogens as a result of maggot meal. This observation was in line with that of Adejinmi (2000).

The control diet would have been expected to show the best growth performance especially in terms of weight gain since it contains fish which is a high level of protein that has been known as the best feed ingredient for fish (Lovell, 1994 and Massomotu *et al.*,1996), but this was not so. However, Lovell (1994) reported that the biological value of protein source does not only depend on its amino acid profile but also on its digestibility as indicated by digestibility energy which increased with increased maggot meal inclusion. Fibre content of feed has been documented to enhance growth performance in fish (Steffen, 1989), the low fibre content of control diet might have also been a considerable factor for a low growth performance especially in relative to 25% maggot meal-based diet. The results on the survival rate indicated that the feeding of *H. longifilis* fingerlings with maggot diets can result in high survival rate. This cannot be unconnected with the high acceptability of this meal as indicated by the voluntary feed indicator and better protein rating of the feeds which was observed during the study (Faturoti, 1991, Babatunde, 1997, Newton *et al.*,2005).

The actual feed production cost and harvesting of maggot (Sogbesan *et al.*, 2006) is confounded by the associated benefit to livestock- poultry producers' gain from manure management. Since fish meal production requires labour, fuel and equipment one could assume that the equipment used to collect poultry manure, culture and harvest live maggot and process dry maggot meal might cost the same amount as reported by Newton *et al.* (2005) but the cost of feed production did not agree with their report. The cost benefit report in this study also justifies the growth performance findings. Based on these results, the use of maggot to substitute the costly fishmeal to about 75% inclusion level is recommended to fish farmers and feed industry though there is a need to appraise large scale production of maggot.

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Table 1. Formulation and Production cost of experimental diets.

Feed Ingredients	MM_1 (Control)	MM_2	MM_3	MM_4	MM_5
O% inclusion of maggot	0	25	50	75	100
Fish Meal	30.0	22.5	15.0	7.5	-
Maggot Meal	-	7.5	15.0	22.5	30.0
Blood Meal	5.0	5.0	5.0	5.0	7.5
Groundnut Cake	30.0	33.0	42.0	49.5	51.5
Yellow Maize	30.0	28.0	18.0	10.5	6.0
Soybean Oil	2.0	2.0	2.0	2.0	2.0
Binder	0.5	0.5	0.5	0.5	0.5
Bone meal	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Vitamin / Mineral Premix	1.5	1.5	1.5	1.5	1.5
Total	100.0	100.0	100.0	100.0	100.0
Calculated Crude Protein %	40.10	40.01	40.01	40.01	40.00
Calculated Gross Energy kJ/ 100g	2018.05	2026.29	2039.17	2047.62	2049.46
Cost of production (₦/kg of feed)	822.90	716.40	646.90	577.40	507.90

Table 2 Proximate and energy composition of the experimental diets treatments.

Composition	0% Maggot meal (Control)	25% Maggot meal	50% Maggot meal	75% Maggot meal	100% Maggot meal
Crude protein (%)	41.16	41.43	41.71	41.98	42.25
Ether Extract (%)	8.87	10.92	12.96	15.00	17.04
Crude Fibre (%)	3.02	3.20	3.38	3.56	3.74
Ash (%)	8.57	8.19	7.34	7.38	6.98
[1]Nitrogen Free Extract (%)	24.46	22.30	20.61	18.04	15.90
Dry Matter (%)	86.08	86.04	86.00	85.96	85.91
Gross Energy kcal/100g	1742.13	1794.55	1854.81	1898.99	1951.04
[2]Digestible Energy kcal/100g	1447.96	1494.13	1547.37	1587.53	1634.40

Table3. Growth parameters, Feed utilization, Cost benefits and haematological indices of *Heterobranchus longifilis* fingerlings fed maggot meal-based diets.

PARAMETER	MM_1 (Control)	MM_2	MM_3	MM_4	MM_5
Initial weight (g)	2.10	2.15	2.10	2.08	2.18
Final Weight (g)	9.30	10.88	9.49	7.43	6.98
Weight gain (g/fish)	7.20^a	8.73^a	7.39^a	5.35^b	4.80^b
Relative growth rate (%/fish)	343^a	406^a	352^a	257^b	220^b
Metabolic growth rate	29.36^a	31.99^a	29.74^a	25.22^a	23.32^{ab}
Specific growth rate (%/day)	0.92^a	1.01^a	0.94^a	0.79^b	0.72^b
Voluntary feed intake	1.71^a	1.56^b	1.55^b	1.56^b	1.51^b
Feed conversion ratio	1.89^{ab}	1.63^a	1.70^a	1.94^b	2.01^b
Protein rating	0.10	0.12	0.11	0.08	0.07
Protein efficiency rate	1.28^b	1.48^a	1.40^a	1.22^b	1.17^b
Gross Energy Intake (kJ/100g)	2383.23^a	2560.82^a	2337.06^a	1974.95^b	1892.51^b
Survival (%)	100.0	99.0	99.5	98.5	99.5
Condition factor	1.37^{ab}	1.23^b	1.6^a	0.97^c	0.95^c
Haematocrit (%)	17^a	22^a	22^a	20^a	23^{ab}
Haemoglobin (g/dl)	5.67^a	7.21^b	7.33^b	6.68^b	7.68^{bc}
White blood cell	1.80	1.69	1.65	1.59	1.63
Clotting time (sec^{-1})	45	40	42	46	45
Profit index	7.86	9.90	11.14	11.83	12.99
Incidence of Cost	1.56	1.17	1.10	1.13	1.03
Benefit cost ratio (BCR)	1.34	1.55	1.44	1.17	1.07

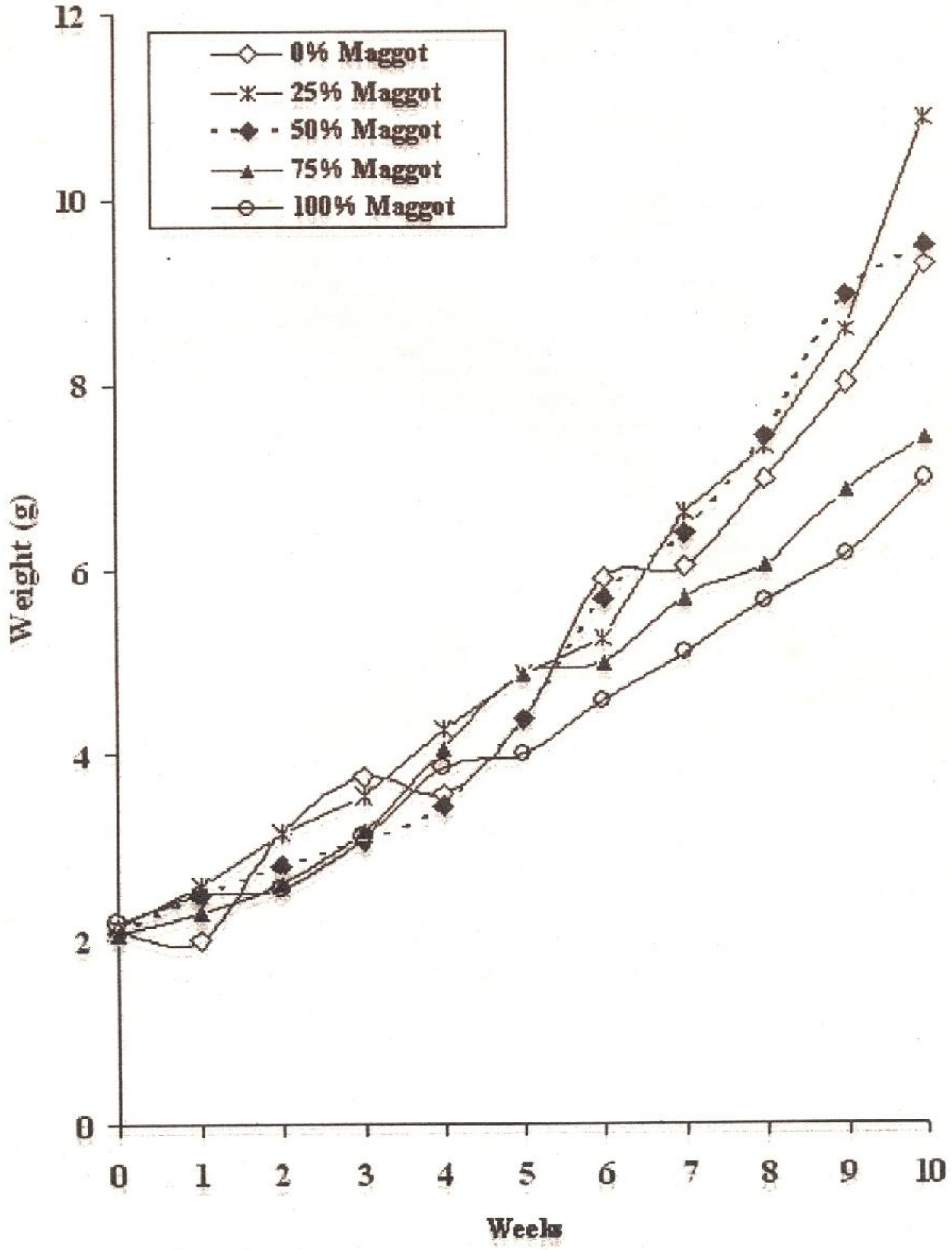

FIGURE 1: Growth pattern of *Heterobranchus longifilis* fed Maggot meal based diets for 70 days